Costs and Benefits of a Renewable Portfolio Standard in Florida

UNDERGRADUATE RESEARCH THESIS

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Abstract

The purpose of this study is to assess the costs and benefits of issuing a renewable portfolio standard in Florida. A renewable portfolio standard (RPS) is a regulatory mandate that forces state utilities to sell a percentage of their electricity that comes from renewable energy. This results in an immediate to medium term increase in energy prices. Currently, only 29 states and Washington D.C. have adopted RPS'. A complex financial model was created to test different scenarios of a base case (assuming no RPS), 15%, 25%, and 50% RPS levels. For example, by year 2050, 15% of energy consumption will come from renewables and so on. The methodology to calculate cost was to find the incremental costs in electricity up to year 2050. For every one percent increase in renewable energy, leads to a .06-cent increase in electricity rates. The benefits in this study are associated with the reduction in carbon dioxide emissions. This study finds the amount of carbon dioxide emitted multiplied by the social cost of carbon derived by the EPA. Then, in the 15%, 25%, and 50% scenarios, we subtract each carbon dioxide emissions from the base case to find the reduction. The results show that the benefits outweigh the costs in all scenarios. In 15%, 25%, and 50% respectively, the costs associated are roughly $11B, $16B, and $28B, while the benefits are $21B, $24B, and $31B. Lastly, the financial model also includes the possible revenue stream of a Renewable Energy Certificate (REC). For every one mega-watt hour of renewable energy that is produced equals one REC. The results show that it is possible to completely hedge away costs in all scenarios if a REC is priced anywhere between $55 and $58. In conclusion, this study is to show implementing an RPS is cost effective and policymakers can use the methodology across the nation.

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Vita

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Major Field: Business Administration- Finance

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I. Introduction

The purpose of this study is to assess the costs and benefits of a Renewable Portfolio Standard (RPS) in the state of Florida. By studying the incremental costs and savings in carbon dioxide emissions can give us a reasonable answer to see if whether the benefits outweigh the costs. The base of the financial model is to project energy sources in Florida up to 2050, to calculate the additional costs to deploy renewable energy and to calculate the savings in carbon dioxide because more renewable energy will be deployed. After taking the net present value and discounting these metrics we can compare two numbers and simply see if the costs exceed the benefits and vice a versa.

The structure of this thesis is going to give some important background at first to help readers not familiar with current energy trends in Florida currently. Next, the thesis will examine some of the few studies that observe impacts of RPS to help get a gauge on what happens to electricity prices when a state adopts an RPS, and also explains why states adopt an RPS in the first place. Additionally, this study will give a detailed section on methodology and how we came to the calculations. Followed by a discussion on the results and what it implies in the conclusion.

As the human population grows, the world naturally needs to produce more energy to sustain an increasing population. Unfortunately, sustaining such population growth has created a negative externality on the global environment in which we live in. We have been obtaining energy from fossil fuels, which during consumption, release harmful greenhouse gases, especially carbon into the atmosphere. This will try to find a monetary value of this negative externality and explore the mechanism of Renewable Portfolio Standards (RPS) to combat climate change, but also assess the costs that come with it.

First off a renewable portfolio standard is a "regulatory mandate to increase production of energy from renewable sources such as wind, solar, biomass and other alternatives to fossil fuels and nuclear electric generation" (**nrel.org**). As you can see in **Figure 1** that 29 states have adopted an RPS. Meaning that each of the 29 states will have to obtain a percentage of their energy from renewables. Specifically, the RPS instrument places an obligation on utilities to obtain a variable amount of renewable energy for the supply of electricity.

It is important to look at all the historical and current figures of Florida before assessing the cost-benefit analysis to gain a better understanding how much energy Florida uses and the percentage of sources it obtains energy from to generate electricity. All numbers are derived from the Energy Information Administration (EIA).

In **Figure 2** in the appendix you can see the trend of Florida's carbon dioxide emissions from the electric power sector. Coal, petroleum, and natural gas are the three main energy sources being examined. According to the EIA in 2012 and 2013 respectively the grand total of carbon dioxide emissions from fossil fuels to generate electricity among those three energy sources in the state of Florida were 218.4 and 217.6 million metric tons. The hope of an RPS is to reduce this metric, and the benefits are calculated by finding a monetary value of this reduction, which will be explained later.

First, looking at coal's most recent figures provided by the EIA, in 2012 carbon dioxide emissions from coal was 44.4 million metric tons. On a bigger picture, roughly 41 percent of electricity consumed was powered by coal. In 2013 coal emitted 46.3 million metric tons of carbon dioxide roughly 44 percent of the total.

Next, petroleum products was only a mere 1.3 million metric tons for carbon dioxide emissions; only 1.2 percent of the total electric sector's emissions. Petroleum products increased from 1.3 to 2.6 million metric tons. Translating to 2.4 percent of the total electricity sector.

Lastly Florida consumes a huge amount of natural gas to generate electricity at around 105 million metric tons in 2013, which constitutes roughly 57 percent of the total carbon dioxide emissions of the electricity sector. Again, all figures are provided by the EIA.

In terms of British thermal unites (BTUs) the state of Florida according to the U.S. Energy Information Administration consumes 505.2 trillion BTU's of coal; 930.4 trillion BTU's of ethanol and the largest energy the state consumes is natural gas at an immense 1,245.2 trillion BTU's. Looking on the other side of the glass unfortunately, Florida does not consume that much renewable energy. Nuclear power is the largest form on renewable energy Florida consumes at 277.2 trillion BTU's. Biomass comes in second at 254.3 trillion BTU's. Wind and solar energy are so small that the U.S. Energy Information Administration groups them under "other renewables" that account for 58.8 trillion BTU's. It is important to look at these figures because this study will use historical data to project energy consumption through year 2050.

One of the assumptions in this study is that the true costs of passing an renewable portfolio standard will be the change in electricity prices. It is important to give an overview of the electricity sector's figures for the state of Florida. To no surprise most of the electricity is produced from natural gas. In 2013 according to the U.S. Environmental Information Administration (EIA) 15,099,000 mega watt-hours of electricity produced from natural gas. The second most used source of energy was coal of 4,170,00 mega watt-hours of electricity produced. The whole point of the renewable portfolio standard is to reduce the amount of electricity generated from coal and natural gas. This is an extremely hard thing to measure especially as a monetary value but in the year of 2013 only 437,000 mega watt-hours of electricity was generated from “other renewables.”

Overall, all this information derived from the EIA is extremely crucial to this study, because it is the base of the financial model to assess the costs and benefits. Forecasting the energy mix up to year 2050 will be based on the historical data and examining trends is crucial to have an accurate estimate on how many metric tons of carbon dioxide will be emitted.

This paper examines the incremental cost of issuing an RPS in the state of Florida and the benefits that come from the difference in savings carbon dioxide emission comparing different scenarios from a base case. The base case in the model is assuming “No RPS” and the costs are derived from the natural population growth and also the current trend of renewable consumption, which will be around 0.64% of total energy mix by year 2050. The other three scenarios run are assuming an RPS level mandate of 15%, 25%, and 50%. Meaning, by year 2050, the respective percentage of energy mix to power the electric power sector will come from renewables.

Lastly, the study examines the potential revenue stream for Renewable Energy Certificates (RECs). “A renewable energy certificate, or REC, is a market-based instrument that represents the property rights to the environmental, social and other non-power attributes of renewable electricity generation. RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource” defined by the Environmental Protection Agency. “RPS policies commonly include a system of renewable energy credits (RECs) in which renewable energy producers generate one REC for every MWh of renewable electricity produced. RECs can be bought and sold to help electricity providers meet their RPS obligations. (Upton, Synder).” REC’s can be traded between states or even within the state. As of now REC's are essentially around $5. However, there is something called a solar renewable energy certificate (SREC) that is much more valuable. The reason we can assume a SREC value is because if an RPS is passed in Florida, most of the renewable energy will come from solar. The model finds a break-even analysis to see what the price of a REC needs to be in order to completely hedge away the incremental costs.

II. Literature Review:

There has been much debate and discussion whether Florida should pass an RPS. There are many variables and reasons why states have not yet implemented an RPS, however only limited studies tell us why. Furthermore, there are currently no studies to knowledge that project future costs and benefits of an RPS such as this one. This literature review is going to discuss pertinent information to expose how RPS' affect costs, and what factors drive states to adopt them in the first place.

Firstly, Florida is a regulated market meaning a medium of the exchange of goods or services (in this case energy) over which the government has a certain level of control. Under Florida law only three utilities (Florida Power and Light, Duke Energy and Tampa Electric) can sell power directly to consumers. With strong lobbying groups backed by the government, they can control the prices. The problem, which arises, is the government has very little incentive to build renewable energy.

"Currently, Florida is one of only five states in the nation that prohibit citizens from buying electricity from companies that will put solar panels on your home or business" (Sherman, 2015). The major issue is that Florida prohibits third-party owned solar systems. The financial mechanism behind the success of the third-party solar comes from the Power Purchase

Agreement (PPA). Under this agreement, a developer builds solar on someone's property for free and the property owner must buy its energy from that developer. Florida currently bans this, and furthermore, Florida forces all energy produced by solar power generators to first be sold to one of three utilities at a discounted rate (Sherman, 2015). Ultimately, this creates little incentive.

There is only one study that conducts a cost-benefit analysis on the effects of issuing a Renewable Portfolio Standard by the National Renewable Energy Lab (NREL) written by Heeter et al NREL has obtained information from states with existing RPS portfolios and summarizes the costs and benefits only from 2010-2012. Furthermore, the costs incurred are based on the incremental compliance costs to adhere to RPS; meaning, utility and energy companies will be penalized if they do not meet their yearly requirement of renewable energy consumption. This study conducted by Heeter et al should be taken lightly due to many limitations. Of the 29 states that have issued a state RPS, the comparisons that Heeter et al makes are imperfect because each state has different underlying assumptions and methods. Second, they are not finding future costs to society, unlike this study. Heeter et al just documents over a two -year period what is the cost to utilities. The assumption in this study is that additional costs to deploy renewable energy will be passed onto end-users in the form of higher electricity rates. Overall, Heeter et al has concluded that incremental costs will be at or below 2% of average retail rates, and compliance costs for issuing a RPS will be 0.9% of retail electricity rates. These are good gauges for this study to strengthen validity.

Chen et al performed a similar study in 2009. Chen et al summarizes that state RPS-induced rate impacts will be modest for the most part. More than half of the states in their study reported rate increases between zero and one percent. The median sample shows an increase in retail prices of 0.8 percent. However, Chen et al finds that in Eastern RPS states forecast higher cost impacts because the regions lower renewable resource potential. Overall, Chen et al finds the average increase in price is less than two dollars per month.

Sekar and Sohngen in 2014 analyze the effects of RPS' on carbon intensity. They conclude that RPS policy should directly lower carbon dioxide emissions since it is a state law to use more alternative energy. However, because these energy sources cost more, retail electricity prices should rise, and this will likely cause a reduction in energy consumption and consequently carbon emissions (Tidball et al. 2010). The most important piece of the cost assumption of this study is derived from Sekar and Sohngen's findings that for every one percent increase in renewable energy, there is a .06-cent increase per kilowatt-hour in electricity prices.

It is important to research a little deeper and find out why some states adopt Renewable Portfolio Standards while other states do not. A study conducted by Upton and Synder assess the reasons for RPS adoption. They have concluded that three main factors that influence states to adopt an RPS are political, economic, and renewable potential. Upton and Synder conclude that political influence is the strongest factor and they find states that have relatively high Gross State Product (GSP) and more democratic state legislators are more likely to adopt an RPS than states with relatively low GSP and more republican state legislators. It is important to note that political factors trump economic factors. Florida has the fourth largest GSP in the nation according to the Bureau of Economic Analysis; however, Republicans outrank Democrats in the legislature. Upton and Synder concluded that the greater potential of success for renewable deployment, the more likely the state will adopt an RPS because they will incur less compliance costs. Furthermore, Florida ranks third in potential solar power capacity, but is only ranked 13th in terms on installations (Sherman, 2015). However, "Wind and solar potential simply do not guide legislators' decisions about RPS adoption" (Upton and Synder, 2015).

There are few studies that analyze the effects of issuing an RPS; however, we see that electricity rates will rise with the issuance of a RPS. Also, there is strong evidence that states that are more energy intensive, consume more electricity (Florida is 2nd in the country) and have large potential to for renewable energy are more likely to pass an RPS. However, we see that the state of Florida being controlled by Republicans are not in favor of this, and that government influence is very strong. Practically controlling the energy industry, in 2015, the Public Service Commission approved utilities to end all solar rebates, and cut energy efficiency goals by 90% (Sherman, 2015).

III. Hypothesis

It is obvious that we are starting to live in a shifting world to become more sustainable. However, without the support of the government, it is not possible. This idea of a renewable portfolio standard was created in the United States to mandate states to obtain energy from clean sources. However, there are both advantages and disadvantages to passing a RPS. Being a native Floridian, and having one of the greatest potential for a solar state, it is astonishing that Florida has not passed one yet.

Hypothesis: If the state of Florida passes a renewable portfolio standard, then increasing energy costs will be less than the savings in carbon emissions.

IV. Methodology

a. Data Collection:

The data collected came from the Energy Information Administration (EIA). The EIA provides statistics on energy consumption for each energy source. The data collected came from 2004-2013 of energy consumption by source for the electric power sector only. The reason this study looks only at the electric power sector is because the other industries are not pertinent since the utilities are the one's being affected directly.

b. Data Assumptions:

The first assumption, stated above was that all figures obtained were based off of the average historical percentage changes for each energy source. Simply calculated:

1. ***(energy source consumption 2005- energy source consumption 2004) / energy source consumption 2004***

This step can be repeated up until year 2013. After that we take the average of the percentage changes.

2. (sum of percentage change 2004-2013) /10

The findings show that both coal and petroleum decrease by two percent per year. Wood and Waste increase by half a percent per year and nuclear has grown 0% in the last decade as most states are abandoning it, so this figure was left out of the analysis. These are the constant growth projections used up to 2050 in all scenarios. Lastly, total annual energy increases at two percent per year. This is assumption was obtained from the EIA as they have stated that average electricity demand growth for Florida has been around two percent since 2008.

Next, in all 4 scenarios ran, Natural Gas is the dependent variable and Non-CO2 (renewable energy) is the independent variable. In all scenarios, the Non-CO2 is growing at a rate to reach the desired RPS goals by 2050 of 15%, 25%, and 50%. Using trial and error, Non-CO2 sources need to grow by 15%, 16.5%, and 18.75% per year to reach its respective targets. Hence, this is the independent variable because it is changing. To calculate Natural gas is as follows:

3. total energy- (coal + petroleum +wood and waste + Non-CO2) per year

It is important to note, in this study Non-CO2 sources and natural gas are the only energy sources that are changing in all scenarios. As more renewable energy is being deployed, natural gas is the source that will decrease in relation to keeping the total energy growth at 2%. The reason for this assumption is because natural gas accounts for 61% of energy consumption to power electricity in the state of Florida, as shown by the EIA.

The last assumption is when calculating the Net Present Value (NPV) this study uses a 3% discount rate in all scenarios. The justification for this is the Environmental Protection Agency (EPA) gives us the social cost of carbon using a 3% discount rate. To keep this model consistent, the 3% rate was used to find the NPV.

c. Conversion Factors:

Before jumping into the analysis, there are many conversions before finding the incremental increase in costs. The model starts with Trillion BTU's (British Thermal Units) because this is what was given by the EIA. Next, BTUs must be converted to billion kWhrs (kilo-watt hours), then to tons of CO2 (carbon dioxide). The following are conversion factors to convert BTU to kWh given by both the EIA and from Sekar and Sohngen's study:

4. Coal, wood and waste: (xBTU x 1,000) / 10,444

5. Petroleum: (xBTU x 1,000) / 10,156

6. Natural Gas: (xBTU x 1,000) / 8,712

7. Non- CO2: (xBTU x 1,000) / 9,750

Next, kWhrs must be converted to annual carbon dioxide emissions provided by the EIA:

8. Coal: billion kWhrs x 1

9. Petroleum: billion kWhrs x 1.09

10. Natural Gas: billion kWhrs x 0.5

11. Wood and Waste: billion kWhrs x 1

Remember, that there is no conversion for Non-CO2 sources since they do not emit carbon dioxide.

d. Analysis:

Four different scenarios were run to see the effect of a RPS. The first being the base case scenario, which assumes no RPS, and there is no increase in renewable energy. This base case is needed because the three other scenarios are the incremental costs from this one. As stated previously, the other three scenarios are if the RPS goal by 2050 is 15%, 25%, and 50% respectively.

The costs are incremental based on the percentage of renewable energy. For every one percent increase in renewable energy, there is a 0.06 cents increase per kWh. Essentially, these are the additional costs incurred if an RPS is passed. The following are the steps to reach this result:

12. Non-CO2 kwhrs / total kwhrs (this yields % renewable per year)

13. (% renewable year(x) - % renewable year 1) * .06 cents (this yields price change in $/kWh)

14. Price change $/kWh year(x) * total kwhrs year(x) * $1,000,000,000

Putting it all together we get the following equation:

15. (((non-CO2 billion kWhrs / total billion kWhrs) - % renewables year 1) * 0.06 * 1000000000)

Last, using the NPV function in Excel, the model takes the incremental costs from the above calculations from 2015-2050 and discounted at 3%.

Next, explains how the benefits are calculated. The benefits are the incremental savings in carbon dioxide emissions based on the EPA's social cost of carbon dioxide per metric ton at a three percent discount rate. The benefits are calculated by first finding the damages in carbon dioxide emissions for each scenario by taking the sum total of a year's carbon dioxide emissions and multiplying by the EPA's social cost of carbon. Please refer to Table 4 to see the social cost of carbon.

16. Sum of each sources CO2 emissions times social cost of carbon year(x)

Then finding the NPV discounted at three percent. However, it is important to note that the appropriate benefits compared to the costs needs to be the difference from base case carbon dioxide emissions (damages) from each different scenario. To calculate the benefits is as follows:

17. NPV of Base case damages in CO2 – NPV of RPS(x) damages in CO2

Theoretically, the higher the RPS mandate, the less amount of CO2 emissions, which means less damages in society and ultimately leads to more savings.

The last piece of the analysis was analyzing the potential revenue stream of renewable energy certificates (RECs). To calculate the REC/SREC for each year is simply just the total amount of renewable energy production times its value year over year multiplied by one million to convert billion kWhrs into MWhrs.

18. Billion kWhrs Non-CO2 source x value of REC x 1,000,000

Then finding the NPV by discounting at three percent rate. Two different scenarios were conducted. The first one was what would be the potential revenue if the REC were prices at five dollars. The second scenario was what would the price of the REC need to be to completely hedge away costs. This value was found using the goal seek function provided on excel.

V. Results

The results have upheld the hypothesis in this study. For each scenario ran, the incremental savings in carbon dioxide emissions have exceeded the increase in costs to deploy renewable energy. Taking a step back, the average retail electricity rate in Florida is 11.58 cents and the average consumption is 1,141 kwh per month totaling to $132.16 according to the EIA. Hypothetically, for every one percent increase in renewable energy, your electricity rate will increase to 11.64 cents (0.06 cent increase) totaling to $132.81 per month. That is only $0.65 increase in your monthly electricity bill for every one percent increase in renewable energy.

The results calculated for the base case (No RPS) was a cost of $532.795 million and damages to society (social cost of carbon) of $185.501 billion. Remember, these are the costs that will happen if no RPS is passed and the costs Florida will bare through 2050 at a two percent growth in energy consumption. In the base case calculations, Florida maintains the current renewable energy ratio of 0.64%, meaning there will be a lot of damages by carbon dioxide, so as we see the RPS goal become larger, the damages will decrease.

The first scenario ran was an RPS level of 15%; by year 2050; 15% of the energy mix will come from renewable energy (Non-CO_2 emitting sources). The incremental costs calculated were $10.677 billion and the damages calculated were $164.685 billion. Remember the savings, however, is actually $20.815 billion because it is base case less the damages in a 15% scenario: ($185.501 billion - $164.685 billion). We compare the $20.815 billion > $10.677 billion (Savings in carbon dioxide > incremental costs). Furthermore, the additional revenues that REC's can potentially bring in. If we assumed worst case, and can sell each REC (1MWh) at $5 each, this would create roughly $956 million dollars and reduce costs to about $9.7 billion. A break-even analysis was conducted and found that each REC would have to cost $55.82 cents to hedge costs to $0. To put into perspective, SRECs (solar renewable energy) currently sell for $6-$230 (minimum and maximum) in different markets in the United States. If Florida can sell each certificate for over $55.82 it can potentially be creating a profit.

Next, the model examines if Florida were to pass a 25% RPS level. Costs I calculated were $15.985 billion, total damages were $161.563 billion, and incremental savings were $23.937 billion. $23.937 billion in benefits > $15.985 billion in costs. With a $5 REC, the value created is $1.4B. To eliminate costs completely the value of a REC under this scenario needs to be $57.15 each.

The last scenario examined was if Florida were to pass a 50% RPS level. Costs calculated were $28.036B and total damages were $154.426B. This makes incremental savings in CO_2 emissions of $31.071B and again, benefits > incremental costs. With a REC value of $5, this creates only $2.4B. To break even with incremental costs, the value of a REC needs to be $58.35. Below is **Figure 3** that shows the cost vs. the benefit in all scenarios. It is visible that the difference between the costs and benefits are diminishing with a greater RPS target.

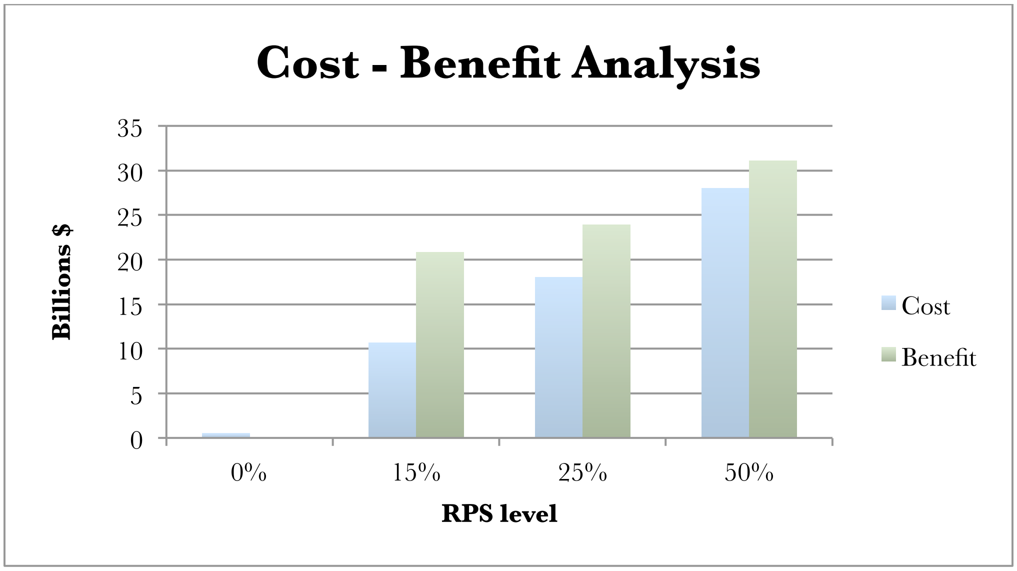


Figure 4 below shows the damages-social cost of carbon over time. It portrays that the damages start reducing at a faster rate when the RPS level increases. This suggests the reason to why the difference between costs and benefits decrease at higher RPS targets.

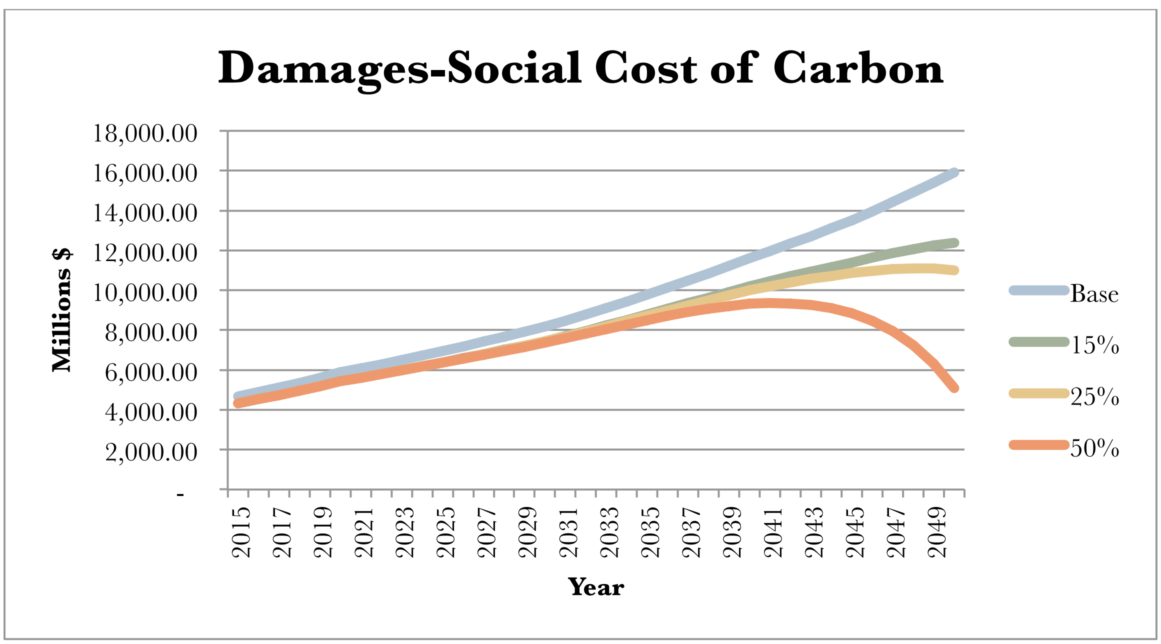
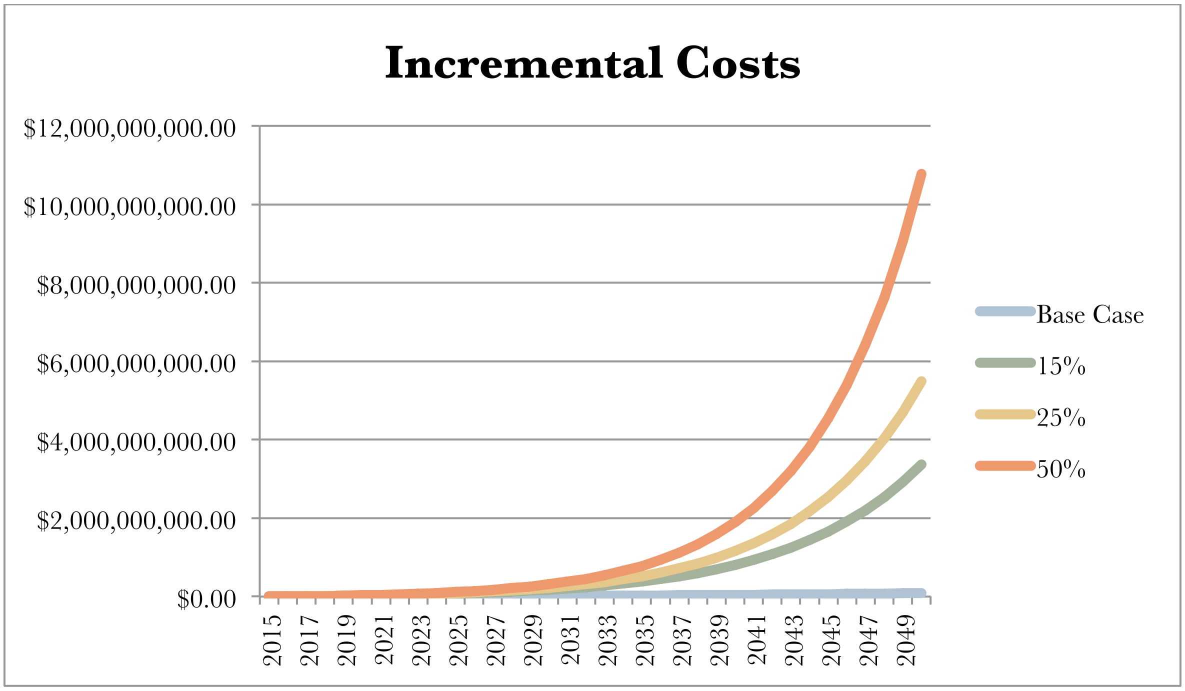
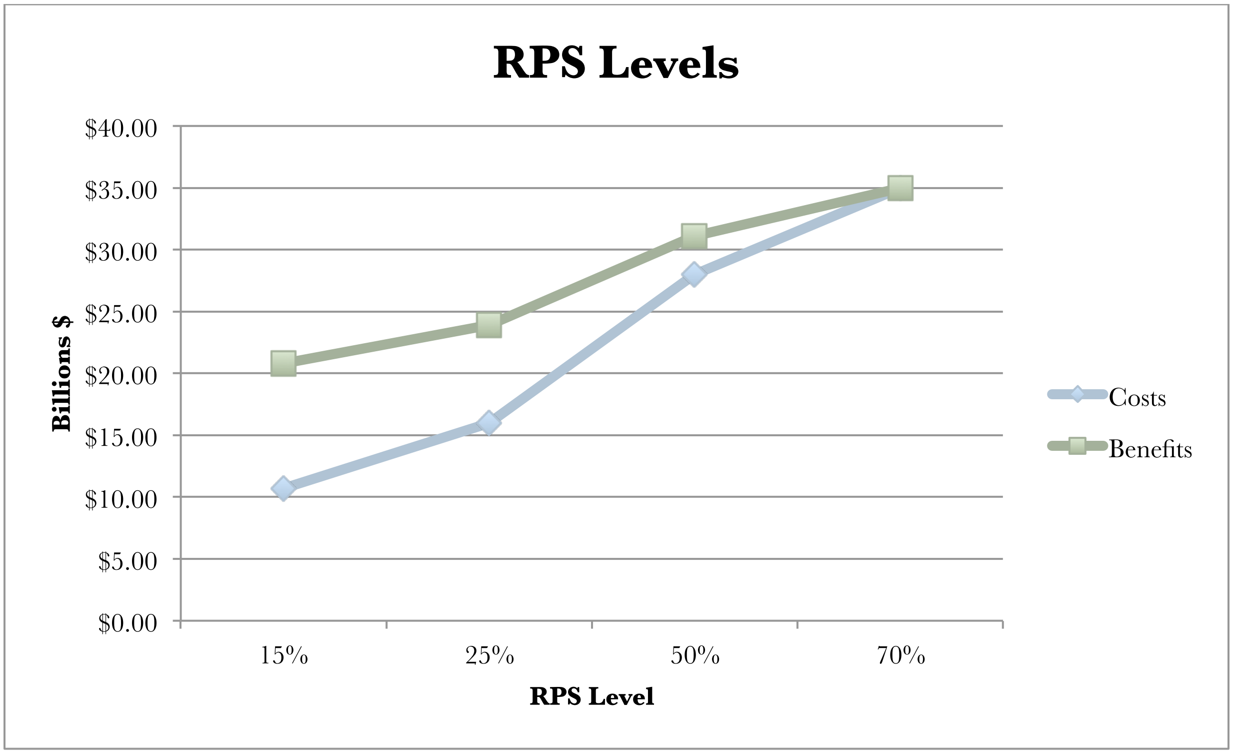


Figure 5 below shows the incremental costs in all scenarios. This is the additional cost that will occur if Florida does pass an RPS. It is apparent that the 50% RPS level incremental costs increase at a much faster rate than the other scenarios.



The last analysis of the study was to figure out at what RPS level would the incremental costs equal the benefits. Finding the optimal point. Again, by using the goal seek function on excel, the optimal point is a 70% RPS level. The costs and benefits will both reach $35 billion in year 2050 as shown below in **Figure 6**.



VI. Conclusion

Overall, the hypothesis has been upheld based on the methods, assumptions, and calculations of this study. As we see, in each scenario the incremental savings of carbon dioxide exceed the incremental costs of deploying renewable sources to meet different RPS levels of 15%, 25%, and 50%.

Additionally, we see that REC values can be extremely valuable as well and can actually create a profit for the state of Florida if sold in lucrative Solar renewable energy markets that value SREC's over $60 each essentially. Something interesting that was observed was that there is a limit to efficiency of these goals.

The following relationships were concluded from this study. First, when renewable energy levels increase, so do the incremental costs. Second, when renewable energy levels increase, the damages to society decrease. Third, as renewable energy levels increase, the incremental savings in carbon dioxide emissions increase. Fourth, as renewable energy levels increase, the value of a REC to hedge costs increases. However, the fifth and last observation is there seems to be a limit on the level of an RPS. For example, in the 15% scenario incremental benefits exceed costs by roughly $10 billion, roughly $8 billion for 25% scenario, and $3 billion for 50% scenario. These benefits remember, do not include the potential of REC's. It was found that the optimal level where costs equal benefits is at the 70% level.

"Cost– benefit evaluations of state RPS find that, if implemented according to law, RPS should reduce carbon emissions from energy production to a greater extent than transition to natural gas (Chen et al. 2009)." A major point to this study is summed in the previous quote. We are living in a world that is starting to become harmed, and a transition to renewable sources is vital for future generations to come. Simply transitioning to natural gas is not the answer, its just building another bridge.

There are many points for discussion that are important to talk about. First, Florida is a regulated meaning that the government controls prices. So if the government and utilities are the ones that need pay for renewable energy, electricity prices will increase. Additionally, it has been examined as mentioned in the literature review, with increasing electricity rates, we will see a natural decrease in electric consumption. This study does not take into account this natural decrease and should be explored in further studies.

Next, there are more benefits that could be examined in future studies. The only benefit taken into consideration in this study was the savings in carbon dioxide emissions. Other health benefits can come from other greenhouse gas reductions that can increase the break-even point between costs and benefits. Also, renewable energy is more reliable energy that is also a benefit. It is hard to put a monetary value on the fact that this renewable energy be used a back-up power in a time of emergency or help the utilities supply energy during peak-hours. Elaborating on this point, in some states solar net-metering a process where solar owners can sell power to the grid for a reduction in utility bills was not taken into account. Essentially, net-metering can be another revenue stream that would increase optimal level of 70%.

Furthermore, not all the risk is taken into account in this study. The three-percent discount is very low meaning low risk, which is not entirely true. Price fluctuations in other sources of energy, such as natural gas, can have a negative impact on the price of electricity. The transition to renewable energy could "increase electricity prices and cause leakage of energy-intensive industries to less regulated states (Fischer 2010; Wei et al. 2010)." Basically, the supply of natural gas will naturally increase if less of it is being used, and this can lead to increases in price fluctuations. Also, utilities in Florida can sell their energy powered by fossil fuels to more deregulated market, which will be an outflow of revenue in the state of Florida. This inherent risk is not incorporated into this model.

The last part of the discussion, and one of the most important is the concept of selling RECs/SRECs. If you sell RECs to another state, or utility, this gives them the right to claim a percentage of renewable energy production to meet compliance cost, but still emit the same amount of fossil fuels. For example, selling these RECs cancels out savings in carbon dioxide emissions. So the question is, is it fair to use RECs as a way to hedge costs away if carbon dioxide is still be emitting elsewhere?

Overall, this is just a simple financial model that was created that excludes many variables that would alter the projections. The hopes of this study is to create a template and a start for policymakers across the nation to use for when they are evaluating if their state is looking to implement a Renewable Portfolio Standard.

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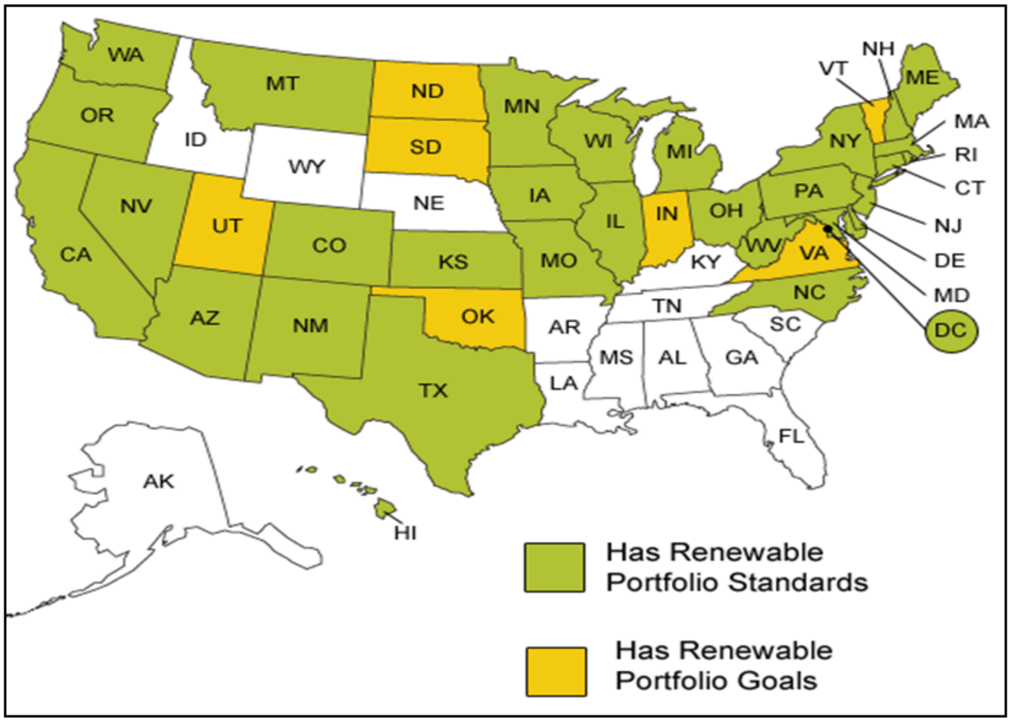
Appendix:

Figure 1:



https://www.eia.gov/todayinenergy/detail.php?id=4850

Figure 2:

Florida's CO2 emissions by fossil fuels (million metric tons)	Electric Power Sector	
	2012	2013
Coal	44.4	46.3
Petroleum	1.3	2.6
Natural Gas	107.0	104.6
Total	218.4	217.6

https://www.eia.gov/state/data.php?sid=FL#ConsumptionExpenditures

Table 1: Incremental Costs and Social Cost of Carbon

	Costs	Damages (CO2 emissions)
Base case	$532.8M	$185.5B
15%	$10.7B	$164.7B
25%	$16.0B	$161.5B
50%	$28.0B	$154.4B

Table 2: Incremental Costs and Incremental Savings

	Costs	Benefits (Savings)
Base case	$532.8M	-
15%	$10.7B	$20.8B
25%	$16.0B	$23.9B
50%	$28.0B	$31.1B

Table 3: RECs at $5 and Break-Even Analysis

	REC Value @ $5	Break-Even REC Value
15%	$956,182,100	$55.83
25%	$1,398,494,898	$57.15
50%	$2,402,512,238	$58.35

Table 4: Social Cost of Carbon

Year	Social Cost of CO2 per metric ton
2015	$36
2020	$42
2025	$46
2030	$50
2035	$55
2040	$60
2045	$64
2050	$69